Emmetropization, Accommodation and Strabismus In the Young Hyperope

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Disclosure Statement:
No financial conflict of interest

Studies from our lab were supported by
sensory

motor
Learning objectives

- Normal and abnormal emmetropization during infancy and early childhood.

- Accommodation and vergence performance during infancy and early childhood.

- Expectations for clinical assessment of young hyperopic patients who might be at risk for amblyopia and strabismus
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Biometry:

For an eye to remain almost emmetropic, its total optical power must reduce from 90D to 60D with growth

Mutti & Zadnik ‘Biometry of the eye in infancy and childhood’ in ‘Eyecare for infants and young children’ ed. B.D. Moore
Spherical equivalent:

Saunders KJ, Woodhouse JM & Westall CA, Vis Res, 1995

Rate of emmetropisation related to initial refractive error

Atropine refractions of 1,000 newborn eyes
Operating range of emmetropization?


Mutti DO, 2007, OVS
High incidence of astigmatism $>0.75\text{D}$ in infancy (approx 50%). Reduces over first 2 years. Most studies find ATR in infancy, but a number also find WTR. Mainly corneal.

Anisometropia:

Cycloplegic refraction in the first week after birth:

- Zonis & Miller (1974) anisometropia (>1D) in 17.3% of 300 Israeli neonates.
- Varghese et al (2009) anisometropia (>1 D) in >30% of 600 Delhi newborns.

After one year of age:

- 2-8% end of the first year (e.g. Flom & Bedell 1985 find 3.4%; Blum et al 1959 find 2.3%; Huynh et al 2006 find 1.8%).
- Almeder, Peck & Howland (1990) Infancy to preschool. No cases of persistent anisometropia >1D throughout this period, although did find typical prevalence of approx 2.8%.
- Ingram & Barr (1979) 8% at 1yr and at 3.5yrs. 7 of 12 children traded out between 1 and 3.5 years.


Candy, Wang & Ravikumar, OVS, 2009
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Accommodation….

Adults

SNR = 11.9*

SNR = 19.9*

SNR = 21*

2-4 month-olds

SNR = 1.3

SNR = 3.5*

SNR = 10.5*

Wang & Candy (2010) IOVS
Norms:

Rouse, Hutter & Shiftlett (1984): Kindergarten to sixth grade. MEM, 721 children. Book at their own reading distance. Overall, mean lag 0.33D SD 0.33D, & a small effect of age.

Leat & Gargon (1996): 3 – 10 years Nott, back-illuminated pictures. Mean lag of approx 0.50D, SD < 1D for stimuli further than 12 cm from the subject.

McClelland & Saunders (2004): 4 – 15 years Nott, back-illuminated picture. Mean lag of 0.33 D SD of 0.33 D for a 4D target demand.
Clinical Approach:

Target selection choice depending on your goal …… either:

i) Choose a target that approaches the patient’s acuity, to measure their maximum performance.

ii) Choose a target with more naturalistic content to measure more habitual performance.
Vergence....

Stimulus
Response

5-10 wk olds

Seemiller & Candy (VSS 2015)
(submitted)
How large is the phoria in young children? What is their fusional range?
Sreenivasan, Babinsky, Wu, Candy (ARVO 2015) (submitted)

80cm viewing distance
Sreenivasan, Babinsky, Wu, Candy (ARVO 2015) (submitted)
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80cm viewing distance
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Age of onset of accommodative strabismus

Parks MM. (1958) Arch Ophthalmol
Infants and children with cycloplegic hyperopia tend to have larger and more variable accommodative lags.

Tarczy-Hornoch, 2012, JAPOS

Ingram, Gill & Goldacre, Bull Soc Belge Ophth, 1994

Candy, Gray, Hohenbary & Lyon, 2012, IOVS
Some evidence that the poor accommodators are the infants who will go on to develop strabismus

- Somer, Karabulut, Cinar, Altiparmak & Unlu (2014) Eye

And, that the poor accommodators are less likely to emmetropise

- Ingram, Lambert & Gill (2009) Strabismus
- Mutti, Mitchell, Jones, Friedman, Frane et al (2009) OVS

Both of these results are counter-intuitive
Unfortunately, the evidence from trials of preventative glasses prescription is unclear…….

**Effect of glasses on incidence of esotropia**

- Treated compliant: Atkinson Prg 1 (6.3%)
- Not treated: Atkinson Prg 1 (21%)
- Treated compliant: Atkinson Prg 2 (20%)
- Treated non-compliant: Atkinson Prg 2 (21.7%)
- Not treated: Atkinson Prg 2 (11.1%)
- Treated compliant: Ingram Prg (24%)
- Treated non-compliant: Ingram Prg (23%)
- Not treated: Ingram Prg (26%)

**Babinsky & Candy (2013) IOVS**

A further trial by Somer, Karabulut, Cinar, Altiparmak & Unlu (2014) Eye

See also Jones-Jordan L, Wang X, Scherer RW, Mutti DO. Cochrane Database Syst Rev. 2014 Aug 18;8
Current prescribing guidelines.....

### TABLE 3  GUIDELINES FOR PRESCRIBING EYEGLASSES FOR YOUNG CHILDREN

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age 0–1 year</th>
<th>Age 1–2 years</th>
<th>Age 2–3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Isometropia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(similar refractive error in both eyes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myopia</td>
<td>≥ −4.00</td>
<td>≥ −4.00</td>
<td>≥ −3.00</td>
</tr>
<tr>
<td>Hyperopia (no manifest deviation)*</td>
<td>≥ +6.00</td>
<td>≥ +5.00</td>
<td>≥ +4.50</td>
</tr>
<tr>
<td>Hyperopia with esotropia †</td>
<td>&gt; +2.00</td>
<td>&gt; +2.00</td>
<td>&gt; +1.50</td>
</tr>
<tr>
<td>Astigmatism ‡</td>
<td>≥ 3.00</td>
<td>≥ 2.50</td>
<td>&gt; 2.00</td>
</tr>
<tr>
<td><strong>Anisometropia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myopia</td>
<td>≥ −2.50</td>
<td>≥ −2.50</td>
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</tbody>
</table>

**NOTE:** These values were generated by consensus and are based solely on professional experience and clinical impressions, because there are no scientifically rigorous published data for guidance. The exact values are unknown and may differ among age groups; they are presented as general guidelines.

* May reduce the amount by up to +2.00 D, or if the cycloplegic prescription is ≥ +7.00 D may reduce by up to +3.00 D.

† Give the full cycloplegic prescription. If ≥ +3.00 D, may reduce by +0.50 D.

‡ Any oblique astigmatism (defined as ≥ 15° from the 90° or 180° axis) > 1 D should be considered for treatment.

Preferred Practice Pattern- Pediatric Eye Evaluations - American Academy of Ophthalmology 2002
http://www.aao.org/education/library/ppp/
Implications for clinical care:

- 70% of typically developing infants will have hyperopia between 0 and +4D.
- Which patients are going to emmetropize and which ones are likely to be at risk for amblyopia and strabismus?
- A patient of less than 18 months of age may emmetropize and can be monitored in 2 or 3 month intervals if there are no other signs of abnormality (e.g. Aniso, Acc lag, strabismus, poor VA).
- If the patient is more than 18 months of age and has significant hyperopia (> +4D?) they are unlikely to undergo dramatic emmetropization.
- In terms of prediction, there is now consistent evidence that infants and young children with accommodative lags greater than approximately 1.25D, for a target at a typical near viewing distance, tend to have hyperopia greater than 4D and are unlikely to emmetropize (their additional retinal blur does not appear to drive emmetropization).
- Ingram, Gill & Goldacre (1994) and Somer et al (2014) would also suggest that these are the patients at most risk for amblyopia and strabismus.
- The evidence regarding preventative correction is currently unclear.
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